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ABSTRACT

A study was undertaken to describe how changes in the network of transactions that occur between manufacturers and suppliers have affected the scope and nature of training and related human resource practices within supplier firms. Data came from the published literature, expert opinion, and a phone survey of 15 individuals ranging from manufactuers, suppliers, to training experts. Findings indicated that markets in which U.S. firms and products were competing became increasingly internationalized over the past decade. For supplier firms, that competitive arena was characterized more by issues of quality and delivery, as opposed to strict price considerations. This, in turn, had a significant impact on the use of advanced production and process technologies and induced major structural changes in relationships between suppliers of parts and components and their original equipment manufacturing (OEM) customers. In turn, the structuring in OEM-supplier relationships had an impact on a variety of business and management practices. Suppliers saw more training as being strategically important but were strapped by the inability to deliver it. The resultant pattern was continued reliance on equipment vendors and other third-party providers. U.S. OEMs and their suppliers were moving toward the "Japanese Supplier Model." Enhancement of training delivery capacity within supplier firms was recommended. (Appendixes include 29 references, survey report, and telephone protocol.) (YLB)

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SUPPLIER RELATIONSHIPS AND TRAINING

Contract Report

Submitted to the Office of Technology Assessment by

Louis G. Tornatzky
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Industrial Technology Institute
December 1989

U.S. DEPARTMENT OF EDUCATION
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This contract report was prepared to be used as background material for the assessment on Worker Training.

The assessment entitled, "Worker Training: Competing in the New International Economy," was released in September 1990.

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December 15, 1989

A report submitted to the
Office of Technology Assessment,
U.S. Congress

by

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EXECUTIVE SUMMARY

Findings

The following are the major findings of the study:

1. Relationships between original equipment manufacturers (OEMs) and their suppliers of parts, components, and equipment have changed dramatically over the past 5 to 10 years. The result will be a supplier base which is smaller, more responsive, more technologically advanced, and has longer and more dedicated business relationships with its customers.

2. In order to accomplish this transition, there are heavy pressures on supplier firms to increase the quality of its workforce through training and education. This, in turn, has resulted in a increase in the amount of training, of all kinds, performed in and for supplier firms. Training is seen as a key to remaining competitive.

3. OEMs themselves have in some industries, and in some content domains, played a significant role in the training and upskilling in supplier firms. In most cases this increased role has been in industries undergoing heavy foreign competition (e.g., auto), and in content domains relevant to the quality management function (e.g., SPC). Moreover, the role that OEMs have played has <u>not</u> been one of improving the <u>training function</u> per se in supplier firms. Rather, the emphasis has been on insuring that certain <u>content domains</u> (e.g., SPC) are being addressed. There are few incentives for individual OEMs to address generic training function issues, since suppliers are typically not dedicated to a single OEM customer, and an OEM-initiated improvement effort would equally benefit its competitors.

4. The quality of training performed with and for supplier firms is still relatively low in terms of instructional technology and instructional delivery systems. For example, there is little use of computer-based or electronically-

mediated instruction at this level, and the delivery system itself is highly disaggregated and diffuse.

5. Expected trends in OEM-supplier relationships are likely to shift the focus of productivity improvement efforts, and corresponding training efforts. While the current focus is on quality issues, and production technologies and approaches, the future focus is likely to be on product design and engineering capacity in supplier firms. This trend will be accelerated by a greater reliance on concurrent engineering concepts, modular sourcing, and a slimmer, more dedicated supplier structure. The implication for supplier-based training (and education) is that the locus will move "upstream", with upskilling of design and engineering personnel being more important than heretofore.

6. There is no coherent government policy or approach to the problems of training in supplier firms. Government agencies are typically uninformed about the business and technical environments in which supplier firms operate, and may assume that the mixture of market forces and public initiatives is meeting the needs of those firms.

Recommendations

The following recommendations, for both public and private entities, are offered for consideration:

1. Effort and resources need to be devoted to enhancing the training delivery capacity within supplier firms. These efforts could be mounted by private, public, or partnership organizations, and need to focus on both the instructional technology and human resource components of training delivery (e.g., competent training personnel using effective training tools).

2. The "educational establishment," at all levels, needs to be made more aware of the instructional needs and environments of supplier firms, and suitably incentivized to address those needs.

3. Particular attention needs to be devoted to the potential problem of providing engineering manpower to supplier firms. As product and process engineering expertise is increasingly demanded of these firms, there is no logical source of supply.

4. There is virtually no empirical research at the federal level being devoted to the issues addressed in this report. Given the importance of this cadre of companies to the national economy, it is recommended that resources be devoted to addressing this information gap.

SUPPLIER RELATIONSHIPS AND TRAINING

Introduction

The purpose of this report is to describe how changes in the network of commerce that occur between major manufacturing companies and their suppliers of parts, components, capital goods, and materials have impacted the scope and nature of training and allied human resource practices within those supplier firms. The report will explore changes in the structure of customer-supplier relationships in U.S. manufacturing, associated changes in process and production technologies, effects on the content and delivery of training in supplier companies, as well as some exploration of alternative models of both supplier relationships and training practices as practiced by U.S.-based Japanese manufacturers.

The methodology which drives the conclusions in this report draws heavily on the published literature, expert opinion, and some limited primary data collection.[1] As such, the observations and conclusions described here should be considered as a somewhat tentative, albeit informed, picture of a complex and rapidly changing set of phenomena.

Supplier Relationships and Technological Change

To capsulize what will be developed in more detail in the following sections: markets in which U.S. firms and products are competing have become increasingly internationalized over the past decade, and for supplier firms that competitive arena has become more and more premised on issues of quality and delivery, as opposed to strict price considerations. This in turn is having a significant impact on the use of advanced production and process technologies, as well as inducing major structural changes in relationships between suppliers of parts and components, and their original equipment manufacturing (OEM) customers. In turn, the restructuring in OEM - supplier relationships has had reverberations within supplier firms in a variety of business and management practices.

Changes in World Markets and U.S. Industrial Sectors. Two major types of changes

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[1] A phone survey was conducted of 15 individuals drawn from major manufacturers, small-to-medium sized supplier companies, training experts, and the like. The interview protocol consisted of fourteen questions, structured in an open-ended qualitative format. In addition to focusing on the substantive issues addressed in this analysis, the phone survey was also used to generate the names of other useful respondents in a "snowball" manner. A summary report of the survey is provided in Appendix A. The protocol used in data collection is provided in Appendix B.

have occurred in manufacture markets in the past 10 to 20 years: (1) the decline of the U.S. share, both domestically and internationally; and 2) the increase in the viability and perhaps, more importantly, the number of strong competitor nations.

As indications of the former phenomenon, one can look briefly at the import share of U.S. consumer and capital good sales (Dornbusch et al., 1988). Between 1980 and 1987 import penetration in U.S. markets in consumer goods rose from 6.9% to 11.6%. More dramatically, in capital goods it rose from 14.6 to 37.7%.

In addition, it is useful to see how changes in market share have played out in terms of various industry sectors. If, for example, one considers high technology manufactured products, an area in which the U.S. has heretofore enjoyed considerable success. disturbing trends emerge. As reported by Dornbusch et al., (1988) in no industrial sector (except aerospace and perhaps drugs) has the U.S. maintained the balance of trade it enjoyed a few years ago. There is virtually no U.S. industrial sector which has been impervious to import competition.

TABLE 1
High Technology Balance of Trade
(Billion $)

	1980	1985
TOTAL	27.4	11.7
Drugs	1.0	0.8
Industrial Organic Chemicals	4.2	2.8
Computers and Office Equipment	8.2	2.8
Communications Equipment	0.2	-2.0
Electronic Components	0.9	-4.2
Aircraft and Parts	11.9	12.7
Scientific Instruments	3.0	-1.0

By the same token, although it is common to think of these phenomena as being attributable exclusively to competition by Japan and West Germany, the fact is that the secrets of effectiveness in manufacturing productivity are becoming widely disseminated. For example, while the average rate of growth in manufacturing exports between 1970 and 1985 was 9.0% and 5.3% for Japan and Europe respectively, it was 13% for the developing countries. (See Dornbusch et al., 1988 for additional data). By 1985 the volume of developing countries' exports was $188 billion, exceeding either the U.S., Japan, or Europe. The rise of the newly industrialized countries (NICs) - Korea,

Brazil, Mexico, Taiwan and others - has been spectacular. The U.S. balance of trade with NICs moved from a $26.1 billion surplus in 1980 to a $27.9 billion deficit in 1986.

What are the secrets of competitive manufacturing that these figures imply? While there are major issues of differential wage rates in the case of the NICS, there are other factors which our Japanese and European competitors seem to have learned exceedingly well. They include a mixture of effective use of technology, innovative industry structural relationships, a mastery of the practice and philosophy of quality production, and the development of human resources to perform all of the above.

Technology, Productivity, and Sourcing Relationships. Increasingly, the context and setting in which these changes in technology, quality, and human resource development are being played out is not in the major manufacturing companies themselves, but in those companies which supply them with parts, components, and machinery. For example, it is relatively clear that there is a trend in reducing the number of supplier of firms in order to gain better control of the quality and cost parameters of incoming products, as well as services. In recent survey, 92 automotive supplier firms (Flynn and Andrea, 1989a) were asked to indicate how rapidly OEMs were moving to implement a variety of practices. Reduction in the number of suppliers was rated the second most rapid change (just behind continuous quality improvement) and showed the greatest increase in estimated implementation rate and relative ranking compared to earlier surveys conducted involving the same authors (Cole, et al, 1985). The earlier data indicated that changes in the structure of supplier relationships were moving at a "slow to moderate" pace, whereas the more recent data indicated a "moderate to rapid" pace. These conclusions are also compatible with the survey conducted for this project (see Appendix A). Reduction in the size of the supplier base, at least in direct suppliers to the manufactures, seems to be occurring as the manufacturers introduce new models and platforms.

An interesting parallel to these changes is the perceived growth in supplier engineering contribution. This is a two-fold phenomena. On the one hand, parts and components suppliers are increasingly being expected to participate in the design of the products which they sell to original equipment manufacturers, and at the same time OEMs as well as first tier suppliers are relying more and more on the out sourcing of engineering services per se (Flynn and Andrea, 1989b; Flynn, 1986). This summary statement (Flynn and andrea, 1989a) is instructive:

A vision of a broadly competent supplier seems to be emerging in the

> *manufacturers' selection criteria. This supplier delivers high quality, to schedule, at a competitive long-term price, and has strong manufacturing and engineering capabilities. The preferred supplier will be good across the board, rather than simply best on one or two criteria. (p.22)*

These conclusions (at least in auto) are confirmed in survey data from 328 supplier companies (Helper, 1989). For example, companies reported that the overage number of competitors to produce the same product for a customer had fallen from 2 to 1.5 over five years. The theme of a sleeker, more responsive, supplier structure seems to be prominent. In a study of 1,000 purchasing agents (Dowst, 1989), respondents indicated that they had reduced their vendor base by an average 21%.

Analysts have expected two other related changes in the structure of the U.S. industry: an increase of the tiering of the supply base, and a move to more modular, or system, sourcing. Tiering involves a more unidirectional flow of goods through the levels of the supply base to the manufacturers. This is often represented by a pyramid shaped industry, with parts and components flowing upward to the manufacturers at the apex. One implication of tiering is that smaller suppliers would only rarely sell directly to OEMs, but would instead focus on customers of other "higher level" firms. This structure is attractive to the manufacturers for a number of reasons, and many expect that it would come about as the manufactures reduce their numbers of direct suppliers, and move to sourcing more built-up components, and even complete systems. While the reduction in suppliers appears to be moving along rapidly, neither tiering nor modular sourcing are developing as rapidly as expected three to five years ago (Flynn and Andrea, 1989a). These, too, may be more likely to develop in "lumpy" as opposed to smooth fashion, as the OEMs move to them at new model production rather than in the middle of a production cycle.

These changes are also not being uniformly implemented across all U.S. industry. There is a heavy emphasis on changes in supplier relationships among those industries being most heavily impacted by import competition and less so in other settings. By definition, this has meant high value-added products and markets (See Table 1).

There is also some evidence that changes in sourcing relationships are becoming more routine at the upper reaches of the supplier chain, and have yet to be played out fully among smaller firms. For example, in a study of several hundred firms across a variety of industry sectors (Ford et al., 1989), in which respondents were from medium to larger size plants, changes in supplier market were not seen as a particularly perturbing event

in these firms' business environment. The implication is that many of these changes have already played themselves out among larger supplier firms. This inference is supported by earlier work (Cole, et al, 1985) which suggested that in 1984 the pace of change in restructuring was much faster among larger, first tier supplier companies.

The driving rationale for these changes in supplier and sourcing relationships is the OEMs' desire to achieve rationality and predictability over their inputs of parts and components, particularly in the area of quality and secondarily cost. (Although, as manufactures attain a finer appreciation of full product life cycle costs, such as after-market service and warranty, they have come to realize that quality is interchangeable with cost considerations.) In Helper's (1989) study of auto suppliers[2], she found that suppliers perceived their customers as relying heavily on quality and delivery as criteria for purchasing decisions, closely followed by price and other considerations, such as engineering and financial resources. These same respondents also felt that five years ago price was the prime consideration in those decisions, suggesting a shift in selection criteria. In a recent survey[3] of Michigan manufacturers (Tornatzky et al, 1989) that explored the pace of change in various company practices (technology adoption, human resource policies, and management practices), quality was seen as the primary impetus of the change process. Over 40% of the respondents indicated that quality was the "key element" in their competitiveness, over 3 times the next most frequently-mentioned element.

A corollary of gaining greater rationality and control over supplier flow of supplied parts, components, and services is the ability of manufacturers to attack a smaller number of significant product cost drivers. That is, indirect cost attributable to excessive inventories, waste, and rework. A structural manifestation of a more streamlined, and responsive supplier network has been a greater reliance on "just-in-time" (JIT) inventory systems as well as the allied technologies to enable such systems to work effectively (e.g., MRP, inventory control software). To the extent that these technologies are used to support JIT structures, the training agenda will be tilted in their direction.

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[2]Helper's target population was every first tier auto supplier in the U.S. Of 1024 contacted, she received completed responses from 328 companies.

[3]The initial sample for this study consisted of 300 plants drawn from the Harris Michigan Industrial Directory, stratified into 3 size categories: 100 to 249 employees, 250 to 499 employees, and more than 500 employees. With a response rate of 42%, data were available from 126 plants.

It should be noted, however, that there is some skepticism on the part of suppliers vis-a-vis JIT. For example, in Helper's (1989) study, a majority of her respondents felt that use of JIT did not lead to more stable delivery schedules as they had hoped. The majority of respondents also indicated that they were implementing JIT primarily because their customers demanded it, and that it was simply transferring inventory costs from customers to suppliers. This perception is supported by other data reported by Helper (1989). That is, there seems to be a disparity between the lot sizes delivered by suppliers and the lot sizes produced. While delivered lot sizes seemed to have fallen dramatically in the past five years, there has not been a commensurate decline in lot sizes produced, strongly suggesting that suppliers are accumulating inventory themselves ("JIT Warehouses").

Nonetheless, there has been significant increases in the amount of information exchanged between customers and suppliers, as would be predicted both by a leaner and more dedicated supplier base, as well as JIT philosophy. Helper's (1989) respondents reported that 91% of them now provide SPC control charts to customers compared to 16% five years ago, with similar albeit smaller increases in the provision of production scheduling information, cost data, and breakdowns of process steps.

A result has been that OEMs have put considerable pressure on their supplier network to install a variety of technologies, both "hard and soft", with a particular emphasis on technologies that enable control over production process and communication between OEM and supplier. There has been a heavy emphasis on production planning and inventory control software, as well as the ability to have compatible CAD to CAD linkages between OEMs and suppliers (DePietro, 1987).

Most importantly there has been a heavy push by OEMs for suppliers to implement statistical process control practices and its allied technologies and philosophies. In the survey conducted for this project (Appendix A), a clear majority of respondents identified SPC and related quality management practices as "driving" changes in customer-supplier relations. This is congruent with data reported above.

Two notable trends are worth commenting upon in the way supplier firms are incorporating new technologies. One is **trajectory** in which different types of technology are being brought on line. Second, is the extent to which technology adoption and implementation is moving downwards to firms at the bottom of the supplier pyramid.

Regarding the first issue there is considerable evidence that a particular trajectory of adoption implementation is being pursued. As firms start moving into advanced manufacturing systems, through the incremental addition of specific tools and machines, there is a predictable path that they take. The importance of this fact is that it suggests how the training agenda for supplier (particularly smaller ones) firms is likely to shift over the next years, as more and more firms follow the same adoption trajectory that their larger peers have already followed.

For example, firms seem to be initially adopting technologies related to quality management, inventory control, and essentially decision-making adjuncts. Then they are moving into computerized technologies to assist the design and fabrication process. By illustration, the reader is referred to Figure 1, which is drawn from the recent ITI publication Frostbelt Automation (Wiarda, 1987). Data reported therein were based on a 6-state survey of over 1300 plants.

Insert Figure 1 about here

To elaborate a bit more, Figure 1 instructs us that if any single technology has been adopted, either hard or "soft", there is a 69% chance that it will be production planning/inventory control (PPIC). In a distant second place is SPC with 8% of the sample, followed by CNC machines and programmable controllers. The analysis becomes even more interesting as we start to ask the "what if" questions. For example, what if a company has adopted two technologies, one of which is PPIC. What is likely to be the second technology? As can be seen it is most likely to be group technology or SPC. Conversely, if the company has two technologies one of which is SPC, then most likely the second technology is PPIC, and so on.

The thrust of these findings[4] is quite straightforward: all things equal, firms will be most likely to embark on a path of modernization that places heavy weight on technologies that will enable control over production processes, quality, and allied considerations. Then, perhaps, they will embark on more capital intensive lines of investment and innovation.

Aside from the trajectory of technology adoption just described, we also know that are great disparities across industry sectors, as well as by plant size, in the adoption rate of

[4]These findings can be usefully contrasted with Helper's (1989) data which was drawn from a sample of companies which were all larger, first tier auto suppliers, and which was collected 3 years after the ITI study.

any technology. Again, drawing from the Frostbelt Automation study (Wiarda, 1987), there are persuasive data attesting to these phenomena. Referring to Table 2

Insert Table 2 about here

in which we look at the number of technologies adopted as a function of industry and plant size, the differences in adoption patterns are obvious. For example, the aggregate adoption rate in SIC 37 (transportation equipment) is nearly three times the adoption rate as SIC 25 (furniture and fixtures). By the same token, the aggregate adoption rate is over three times higher in plants of over 250 employees, as in plants of ten to 49 employees.

These data relative to size-specific patterns of adoption of implementation are paralleled by more recent information gathered by Kelly and Brooks (1988). Gathering data from a sample of over 1,000 companies in the metal-working industry, they found a direct relationship between plant size and technology adoption. To quote Kelly and Brooks:

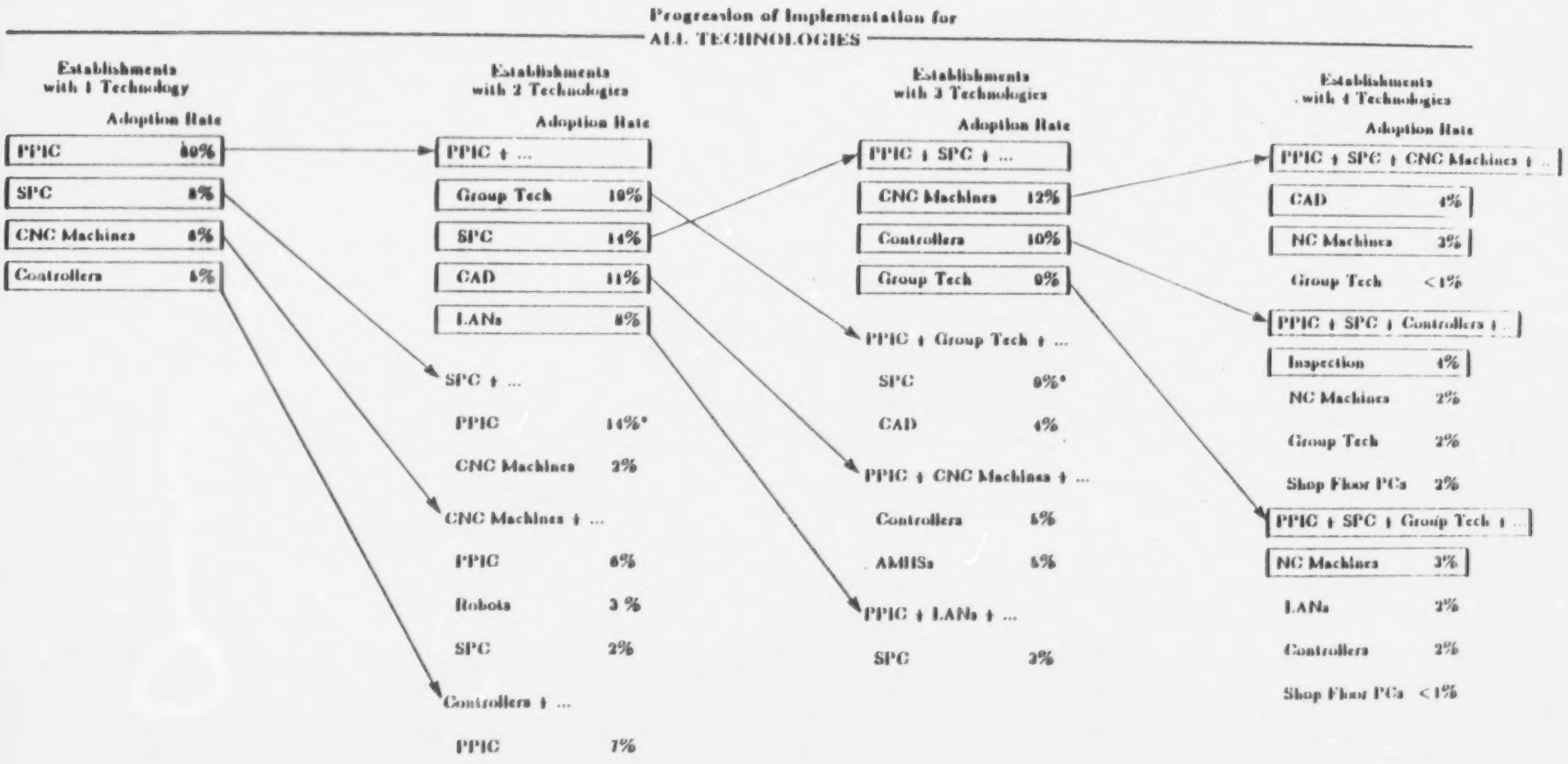
> *At plants with 500 or more employees that are part of multi-plant corporations, the chances are overwhelming (at 18-to-1) that we will find some computerized automation. On the other hand, for small, single-plant enterprises with fewer than 50 employees, the chances that management will have installed any compyted controlled machines are less than 50-50.*

While it is likely that these technology adoption patterns are being influenced by changes in the texture and nature of customer-supplier relationships, empirical evidence to support that assumption is relatively rare. An exception is some preliminary analysis reported by Helper (1989). She found a direct relationship between contract length and use of various technologies. Consider CNC machines. For suppliers with contracts of less than one year, roughly 35 percent of the respondents indicated that they had not adopted the technology. This fell to zero among those respondents with contracts of five years or more. In an analogous manner, Kelly and Brooks (1988) found that industries with a higher share of sales to the Department of Defense were more likely to be adopters of automation. In this case, procurement practices may be accelerating the pace of the adoption curve.

There is, of course, some danger in attributing causal directionality. It may be the case that suppliers get longer contracts because they have greater technological sophistication, rather than they acquire new technology as a result of having longer contracts. A similar confusion exists in DOD--related technology adoption.

Unfortunately, both Kelly and Brooks (1988) and the Frostbelt Automation study

Figure 1



*This technology combination already appears above, with the technologies presented in a different order.

Source: Wiarda, E. Frostbelt Automation, Volume I. Ann Arbor: Industrial Technology Institute, 1987.

TABLE 2

Breadth of Adoption: Industry and Size Comparisons (Number of Technologies Adopted)

Industry (SIC)	Number of Employees 10-49	50-249	250+	All Sizes
24 - Lumber & Wood Prod	0.3	1.3	3.7	0.8
25 - Furniture & Fixtures	0.5	1.6	3.9	1.0
32 - Stone, Clay & Glass	1.0	3.9	4.2	2.0
33 - Primary Metals	1.8	3.4	5.1	2.4
34 - Fabricated Metals	2.0	3.1	4.7	2.5
35 - Non-Electrical Machinery	1.7	2.8	6.2	2.3
36 - Elec/Electronic Equipment	1.2	3.3	5.8	2.2
37 - Transportation Equipment	1.8	3.3	6.7	2.7
38 - Instruments	2.6	3.2	6.2	3.0
39 - Miscellaneous Mfg	0.7	2.6	3.4	1.4
ALL SICS	1.6	3.1	5.6	2.3

Source: Wiarda, E. Frostbelt Automation. Volume 1. Ann Arbor: Industrial Technology Institute, 1987.

(Wiarda, 1987) offer somewhat sobering evidence on the future trends of technology adoption. Kelly and Brooks found that only 1 in 10 production managers at facilities where there is no computerized automation have future plans to invest in those technologies. Similarly, Wiarda (1987) found that an estimated 60 percent of all Great Lakes durable goods establishments expressed no intention of adding new types of programmable equipment within the next two years. While these data are heavily weighted by the responses of smaller plants (smaller plants accounting for the majority of all plants) and certain industries, they are none the less discouraging.

OEM-Supplier Relationships: Interorganizational Innovations. All the above changes have had implications for the texture of the structural relationships between OEMs and suppliers. In business/procurement practices as they have been in the past, customers were likely to have had something akin to a command relationship with their suppliers. In Helper's (1989) metaphor, it was an "exit" relationship. If the customer did not like what the supplier was doing he could exit the relationship.

One example has been OEMs mandating various practices and technologies to be deployed among their supplier firms. The most extreme (and perhaps inappropriate) example of this was the mandating by the automotive OEMs that their suppliers have the capacity for electronic data interchange. Unfortunately, the exchange configurations were different for each OEM, with the result being that for a supplier firm which sold to more than one OEM in this industry, they were forced to acquire highly expensive and redundant capacity. A less intrusive example is the example of Kimberly-Clark which put restrictions and requirements on some of its suppliers for performing SPC tests (and thus have the capacity to perform those tests) on shipments to various KC mills.

In the last four to five years, OEMs have moved towards a give-and-take relationship with their suppliers. In a large survey of purchasing agents and supplier marketing managers, Dowst (1989) found a remarkable similarity in views on issues of quality, delivery, and their importance in overall competitiveness. One way in which they are jointly approaching these issues is through programs to qualify suppliers, which provides a way for OEMs to both shape and support their suppliers, but still retain an arms length relationship (Flynn and Andrea, 1989a, 1989b). While each of the supplier qualification programs has a unique and rating system, they typically are intensive and extensive in nature. That is, they not only look at the technological capacity of the supplier firm, but also its business practices, its human resources practices, and a

variety of other considerations. The importance for the supplier firm, particularly as formal qualification programs become more widespread, is that mastering the topics covered is the key to retaining and increasing business with OEM customers; the importance for our analysis is that these same topics will also drive training and improvement efforts in those firms. To illustrate, these are the following areas of activity that are pursued by the General Motors Targets for Excellence (TFE) program (Modern Michigan, 1988).

Management

- Effective Management Systems including a formal business plan
- Effective Management of Humans Resources including a formal training program
- Management of Sub-contractors
- Responsiveness to GM needs

Quality

- Quality Plans
- Quality Control implementation including statistical process control
- Problem Resolution
- Quality Control of Sub-Contractors

Cost

- Cost Monitoring Systems
- Cost Reduction

Delivery

- On-Time Delivery
- Data Transfer with GM
- Packaging and Shipping Requirements

Technology

- Design and Development Capabilities including access to computer aided design

- Manufacturing Capabilities

The scope of this assessment process has been considerable. As of late 1988, over 1000 assessments had been performed, with nearly 2,000 scheduled. This is out of a supplier base (for parts and components) that approximates 9,000 companies in the General Motors system (Modern Michigan, 1989).

Some OEMs have moved towards more cooperative relationships with vendors as part of the implementation of various forms of advanced manufacturing technology. Some are moving from contract-based to team-based models (Ettlie, 1985; Mahoney, 1982). The joint team is characterized by "multiple coupling" between the two organizations. That is, the equipment supplier and the OEM develop in the context of designing and implementing a new production system a series of side-by-side working relationships involving staff from each organization. In their description of non-linear models of technological innovation, DePietro and Wolfe (1989) refer to this kind of cooperative model as "co-determination." In it, suppliers, vendors, and others work with customers to define problems and choose among alternative solutions. In some cases they engage in co-training as part of implementation. The Saturn Corporation has engaged such a model with GE-Fanuc, its major supplier of factory floor control systems.

Unfortunately for supplier firms, there seems to be only a limited correlation between changes induced in suppliers by the "new relationships" and an increase in new business with OEMs. Although in the long run this will undoubtedly occur, as OEMs reduce the number of their supplier base, but near term changes in procurement often are not readily apparent to supplier companies who go through qualification procedures. Nonetheless, there is evidence that contract lengths -once landed- are increasing. Helper (1989) reports that supplier contracts in auto (in her sample) now average 2.5 years in duration, as opposed to 1.3 years which was the norm five years prior.

While some OEMs have focused their qualifier programs primarily on parts and components, others have broadened their scope to suppliers of capital equipment such as machine tools. Some equipment vendors have responded in quite innovative ways. One company in the printing industry (Johnston and Piskora, 1988) developed a customized rail car, designed to deliver hands-on training to various customers throughout the country.

In few cases customers have provided direct technical assistance to their suppliers as they attempt to change supplier practices, technology, and procedures. For example, one supplier firm which sells to both U.S. and Japanese OEMs indicated that if he had a production problem the Japanese customer would be likely to send an engineer to his shop to help. Nonetheless, the norm tends to be some minimal amount of training referrals or technical support, but highly limited indeed.

It is unclear whether suppliers who are involved in DOD-related products are treated any differently than those in commercial markets. On the one hand, there seems to be a greater proactive push on the part of various DOD programs to promote technology utilization. On the other hand, procurement practices and sub-contracting regulations in DOD work may tend to get in the way of the new style of OEM-supplier "partnership" relationships. For example, one senior executive from a major aerospace company felt that DOD regulations precluded his company from developing dedicated suppliers ala Japanese practice. The next best thing for them is to develop lists of preferred or qualified suppliers, and then apply normal bid and proposal practices to that group. This differs significantly from the kinds of dedicated relationships that are starting to be observed in other industries such as auto, and are more than norm among Japanese companies. The procurement relationship desired by the supplier firm would of course be sole source, rather than competitive bidding.

It should also be emphasized that all of these changes in supplier relationships, particularly among smaller firms, are preceding at a relatively slow pace. This is likely to be an issue that will play out for the rest of the century, although with the change occurring at different rates across different industries in the U.S. We are unlikely to see a highly structured, smaller, and tiered supplier network prior to the year 2000 in most industries.

Intra-organizational Innovations in Supplier Firms. Paralleling these changes in the OEM-supplier relationship, are the number of changes within those manufacturing firms which comprise the supplier base. As supplier companies become more concerned with issues of quality, and new technology, they seem to move more rapidly in terms of changes in general organizational management practices, as well as particular changes in the human resources area. As noted by several researchers (Ettlie, 1985; Kelly and Brooks, 1988) there seems to be a relationship between those organizations which introduce such changes and the ability to assimilate new technologies. As described by Ettlie, there seems to be a needed "synchronistic" relationships between the administrative and technological innovation.

A recent survey of 126 companies in Michigan (Tornatzky, et al., 1989), drawn from a variety of industries, highlights these phenomena. Respondents were asked to what extent they were implementing changes in several inter-related areas including new markets and products, new technologies, new management and organizational practices, and a greater emphasis on training and human resource innovation. All of the questions were posed as to whether firms were doing more now than they were five years prior. Changes in technology use (CAD, CNC, PPIC, SPC, office automation) tended to be positively correlated (r =.42) with changes in training and hiring, as well as new management practices (r = .29) such as participative decision-making and strategic planning.

An example of the relationship between the implementation of new technologies and approaches, and necessary changes in management, can be found in SPC. For SPC tools (e.g., histograms, Pareto analysis, control charts) to have a significant impact on actual productivity, they must be embedded in a "quality culture" that goes from top to bottom in the firm. All levels of management must support the philosophy underlying SPC, as well as the implementation of specific tools.

Unfortunately, there are data which suggest that this optimal outcome is often not realized. Jacobs (1987) reported on an evaluation study of workers who had received SPC training from one of the 17 community colleges in Michigan. Of the 254 respondents to the survey, 25% indicated that the quality/productivity improvements realized by training did not persist in their plants. Roughly 80% of the respondents identified lack of management implementation of the program as the major barrier to long-term gains.

Unfortunately, the proclivity of a supplier firm to pursue training or any other advanced human resource practices also tends to decrease as one moves downward in the supplier chain. For example, 42% of firms with less than 250 employees are likely to use educational attainment as a criterion in hiring, versus 64% of firms with more than 500 employees (Tornatzky et al., 1989). Parallel findings are reported by Carnevale and Gainer (1989), who found that workers in smaller companies, in a variety of industries, were more likely to be younger and have less formal education. Use of formal training programs offered by community colleges is similarly skewed: 37% of the smaller firms use this resource, versus 62% of larger plants (LAMP, 1989). The worker in the larger firm is also more likely to be paid higher, and have journeyman status, perhaps justifying increased investment in human capital.

One interesting change within supplier companies, in direct response to changes in customers, is that they are being more selective in who they are wiling to sell to. In other words, if supplier firms are working the capital investments and the changes necessary for quality and JIT demands, they want to sell to customers who are smart enough to appreciate and value (and value price) their efforts. In the study reported by Dowst (1989), 85% of supplier companies reported being more selective in choosing customers. While this selectivity may not preclude individual orders, it has serious implications for entering into partnership relationships.

Training, Human Resources and Supplier Competitiveness

To preview what will be discussed below: there seems to be a mismatch between the expectations and hopes regarding training, and the actual delivery and benefits derived thereof. On the one hand, supplier firms intend to do more training, and see it as being more strategically important, but they are strapped by the inability to deliver quality training. The resultant pattern is a continued reliance on equipment vendors and other third party providers with only limited participation on the part of OEMs and customers themselves.

Linkages between Training, Technology Implementation and Competitiveness. It is relatively clear that deficits in employee skills are major impediments to the successful implementation of all types of advanced manufacturing technologies. As noted by Wiarda (1987), problems in the skills of operators, maintenance personnel, as well as technical personnel were seen as the primary obstacles to successful implementation, far ahead of more "technical" considerations such as software compatibility or the like.

Not surprisingly then, the scope of training delivered, and the expectations for training benefits have grown considerably. For example, in a study of smaller (mostly less than 250 employees) supplier firms in Michigan, Jacobs (1986) found that in the vast majority of cases (95% or more) firms indicated that they would be performing about the same or increasing the level of training in the future. That same study also indicated a heavy participation by senior management in training decisions and selection of training approaches.

In a parallel study (Ford et al., 1989), which was directed at companies in large part

encompassing higher tiers in the supplier structure, similar results were obtained.[5] For example, of the 350 plus companies contacted, 83 percent indicated that training and development was central either to "some extent" or a "large extent" to strategic planning of the firm. Moreover, 53 percent of the respondents suggested that training provided an adequate return on investment (with only 13 percent indicating skepticism on this issue).

At the same time, there are some dissatisfactions with the quality of training that is provided in supplier firms, as well as the capacity to deliver same. For example in the Ford et al (1989) study, 24 percent of the respondents indicated that training programs were not meeting company needs. This seems to be attributable to a variety of resource constraints such as inadequate number of training and development staff (62 percent), the inadequate skills of training staff (41 percent), and inadequate budget allocations for training and development (36 percent). Data from the Jacobs (1986) study parallel these observations. That is, in 40 percent of the smaller firms in the Jacobs study, there was no training coordinator in residency in the firm. (Although for the balance of firms there obviously was a training coordinator or coordinators). Moreover, virtually all supplier firms tend to be heavily reliant on equipment vendors for their training and secondarily on in-house on the job training as well as third part public sector sources such as community colleges. Those respondents also indicated a lack of funding and shortage of personnel to provide training as important barriers to training.

Unfortunately, there are no data that directly link the scope and quality of a supplier company training program to their competitiveness. While it is true that most of the outstanding supplier companies seem to do a lot of training (as well as other things), empirical and quantitative data are lacking. In small and medium sized firms, training has and continues to be, done largely when only absolutely necessary. In many supplier firms, formal training starts in the area of SPC and quality issues, but whether they implement that training and continue to develop further training is not at all guaranteed. The following respondent quote from the previously-mentioned Jacobs (1987) study is illustrative:

After the class was over it was business as usual. Management could not

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[5]The population for this study consisted of all mid-sized manufacturing firms in Michigan, and thus tended to span the full array of industry sectors. Responses were obtained from companies in the following industries: food; lumber, furniture, paper, glass; chemicals, rubbers, plastics; fabricated metals; machinery and electrical; transportation; fabrics, leathers, textiles; and printing and publishing.

> *have cared less. They did not really want to even go to class; it was felt like a waste of time for us. SPC has not been brought up in our shop since we finished the class.*

Training which is done, in general, often is poorly planned, delivered by less than adequate trainers, has cost the company more than predicted, and has, as a result, had little effect on the companies ability to compete.

Some supplier firms--even small ones--are more proactive and professional in the approach being made to the training function. This includes adequate training personnel, sufficient resources dedicated to the training function, and training that is more an integral part of the organization rather than add on process. In this type of firm, training is more continuous and integral part of the technology implementation process.

In one case described by Heiderreich (1988), one small (175 employees) supplier to Motorola was stimulated by a Motorola-provided training session on quality to initiate a top-to-bottom SPC training program within the company. They used materials and resources provided by Motorola, as well as by Spokane Community College. Partial funding was provided by the State of Washington. The program itself was comprised of four components spread over three months, starting with executive awareness and closing with a train-the-trainer session to ensure continuing training of production and other staff. A few features of this model effort are worth noting: (1) it included several disparate resources, intellectual and financial; (2) it was company-comprehensive in scope, and (3) it was conducted in a way so as to be permanent and self-perpetuating.

Training must be planned and accomplished as surely as equipment selection and implementation, and managers of small firms need to realize that training must be done in order for the modernization to be successful. This is not an automatic response the first time a company deploys new technology but is quickly learned. Training thereafter may be viewed more positively but the lessons are damaging or fatal to the company.

OEM Focus on Supplier Training Practices. There is wide variance in the role that OEMs have played vis-a-vis the actual delivery of the training function in supplier companies. This was the conclusion from our project-specific survey (Appendix A), as well as what we could discern from other published sources. To the extent that the OEMs play a more proactive role, it has included establishment of guidelines, or provision of training in particular generic skill areas.

An important example of the latter is training related to SPC and quality management issues. For example, GM has a program to offer training courses and consulting to its supplier community in the areas of performance improvement and management, quality, costs, and delivery. There is a special course designed to help suppliers to implement the Targets for Excellence program, (described above). In a comparable manner, Ford Motor Company has fostered training in SPC and quality issues. For example with Ford's assistance (in-kind contribution of a staff person, plus access to materials), a national program has been mounted out of Jackson Community College in Michigan. The program has provided train-the-trainer services for literally hundreds of community colleges across the country. In addition, Ford provides on an on-going basis training of its suppliers directly in SPC and total quality control.

Burt (1989) describes analogous activities in other industries. For example, in response to a decline of sales in world markets, Xerox embarked on a major series of reforms vis-a-vis its supplier base. The supplier base was reduced in size from 5,000 companies to 400, and suppliers were trained by Xerox in statistical process control, statistical quality control, just in time manufacturing and total quality commitment. As a result, between 1981 and 1984, new product cost was reduced roughly 10 percent per year, and rejects of incoming materials were reduced by 93 percent. In an analogous manner, Burt (1989) sites the case of D.J. Inc., a major supplier of molded plastic parts to General Electric Appliance. Reportedly, G.E. has not rejected one line of D.J.'s parts in the past 10 years, a record that the president of D.J. attributes to the fact that in 1983 G.E. helped its suppliers in a major training program regarding SPC concepts.

Related Activities in the Area of Training Standards. There has been little activity in the area of training standards per se, with some exceptions. For example, Saturn includes as part of its standards on equipment and machinery, standards for training delivered by large equipment suppliers. Standards have included requirements for documentation, manuals and preventative maintenance programs, and are included in formal specifications in requests for bids for equipment and machinery. These standards, however, are not well enforced.

Other standards or guidelines tend to be indirect, such as acting through supplier qualification programs. That is if a major component of supplier qualification is having a CAD capability, this is likely to influence both technology acquisition as well as associated training practices in supplier firms themselves. SPC training might be required, (or strongly "encouraged") by the OEM in their qualification program in the detection and correction of defects in the products manufactured by the firm.

More direct assistance is often provided by OEMs in the provision of training tapes, manuals, and materials, or by having personnel from suppliers attend training programs paid for by OEMs. This latter approach is still relatively rare.

In summary, the role that OEMs and first tier suppliers are playing vis-a-vis their suppliers in the training area is more indirect then interventionist in nature. There is a tendency to set the framework and context in which training occurs, such as through supplier qualification programs establish implicit standards and the like, and provide only a limited degree of direct assistance. OEMs are also encouraging, directly or indirectly, training provided by other third parties such as not-for-profit organizations, community colleges, and the like. The bottom line, is that no major American manufacturer has established a formal, comprehensive, and sophisticated program of enhancing the training capacity of its supplier firms.

Substance and Format of Supplier Training. The substance of training in supplier companies tends to vary whether one is talking about that which is influenced heavily by the customer-supplier relationship, as contrasted to training which is more normative function of the supplier company's operations. Drawing heavily from the work of Jacobs (1986) and Ford et al. (1989) it would appear that the normal training function runs the gambit from operator-specific skills on new machines to human relations and new management practices. The scope of formal training is fairly limited in most companies, with data (see Carnevale and Gainer, 1989) suggesting that on average it is less than 10 hours during the first, presumably training-critical three months on the job, although the amount of formal training is likely to be double that in larger companies ($>$ 50-0 employees). The amount of informal training is likely to be several times this amount. Total distribution of training effort may be skewed depending upon the nature of the substance or technology involved, but generally there is limited degree of difference between skilled workers, production workers, engineers and management in the amount of training received in most small to medium sized companies (Jacobs, 1986).

The substance of training is heavily oriented towards topics that are especially pertinent to the evolving supplier structure. As has been described above, with the increasing emphasis on just-in-time delivery systems, and product quality, SPC and related quality topics are an extremely common topic. By the same token, with the advent of a more dedicated supplier base (at least at the first tier level), there is an increasing emphasis on topics relevant to engineering design, simultaneous engineering, and allied issues. If

suppliers are to participate in the product design process, they most have the capacity to do so.

Most training, whether influenced by changing customer-supplier relationships or part of the normal menu of training, tends not to be oriented towards radical changes in job skills or job content (Ford et al., 1989). That is, it is much more likely to be focused on updating skills, improving existing skills, and maintaining the skills of experienced workers, as opposed to teaching skills for new jobs that do not yet exist, or totally retraining employees.

The less than 40 hours of formal training mentioned above is supplemented significantly by the more frequent mode of training in small to medium sized companies. That is, the majority of training tends to be on-the-job, in a less than formal context. Formal training that does occur tends overwhelmingly to be provided by vendors of technology, followed by third party providers such as local community and technical colleges, and private training companies. In-house formal instruction tends to be relatively rare, given that few small to medium sized companies have designated and qualified training staff.

Some insight into the substance and format of training in supplier firms can be gained by looking into the particular case of Michigan. Because of the significance of these firms to the state's economy, it has organized the M-JOB-Upgrade program, in which firms with fewer than 500 workers can apply for state funds for their technical training.[6] A unique feature of this program is that unions must approve of the design of the training program and must support the request if state monies are to be used.

As part of its special relationship with Michigan state government, the Industrial Technology Institute has been able to examine data on the training requests to the program (not all were funded) from 417 firms, during fiscal years 1988 and 1989. There were a total of 1331 separate training requests for skills training. Of the 417 firms, 77 were unionized, which is probably double the normal proportion of unionized firms of that size in Michigan. In that sense, then, the data are somewhat skewed.

Nonetheless, an examination of the skills requested for training by these firms gives a

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[6]Grants are awarded on a first-come first-served basis, with applications processed within 30 days. Training can be provided either through community colleges, private training vendors, or through private technical schools certified by the State Board of Education. There is a maximum of $2500 per employee to be trained, and $50,000 per company per year.

good snapshot of the present demand for training in supplier firms. In Table 3 we have presented these requests by skills and fiscal year.

Table 3

Types of Training by
Year of Application

Skills	% Fiscal 1988	% Fiscal 1989
Business Skills	13	14
Production Inventory Control	6	5
CAD & Drafting	9	8
Machinery	6	8
Electrical	2	6
Specific Process (e.g., painting)	10	12
Supervisor & Management Skills	6	5
SPC Quality & Measurement	37	34
Basic Manufacturing Skills	7	4

What is most significant is that over 1/3 of all requests occur in one area: SPC and Quality. There is a slight decline in fiscal 1989, but it remains the most requested area of training for the small firm. This is followed by business skills training(e.g., Lotus 1-2-3, word processing) and then skills involved with the manufacturing processes themselves (painting, material handling, hydraulics). The specific requests for training in the most advanced manufacturing technologies is still surprising low (e.g., CAD, production/inventory control). There is a slight growth (see Table 4) in the number of skills which involved training on software - a suggestion that advanced technologies are being implemented. But the data are not overwhelming.

Table 4

Training Involvement in
Software Programming by Year

	By Year	
	%	%
	88	89
Yes	31	36
No	69	64

Training Delivery Systems. As suggested above, the training delivery systems in small to medium-sized supplier firms is diffuse in the terms of its institutional context, and relatively primitive in terms of instructional technology utilized. There is limited in-house capacity to deliver formal training, and companies tend to rely on a shifting mosaic of training suppliers.

Data from the previously-described Michigan M-JOB-Upgrade program also shed light on this issue. Generally speaking, private firms and community colleges provide the bulk of training under this program, although the split between these two shifts from one technology to another. Private training vendors were selected in the office skills and manufacturing process skills, but the public training institutions were more prominent in the CAD and CNC areas. (See Table 5). Intermediate school districts were a somewhat distant third. There was little training performed in 4-year colleges and universities.

Table 5

Skills Training by Provider (Selected Skills)

	Community Colleges	ISD	Universities	Private
Business Skills	23	1	5	70
Production Inventory Control	39	1	4	56
CAD	47	8	2	44
CNC	59	7	0	33
Electrical	20	8	0	71
Manufacturing Process	23	12	1	64
Supervisor Skills	32	11	5	51
SPC	38	19	4	55
Basic Manufacturing Skills	45	15	0	34

There is little use of advanced instructional design technologies in small to medium-sized companies. For example, in the study by Ford et al (1989), only a minority of respondents were using accepted techniques to determine training needs (e.g., statistical analysis, discrepancy analysis, utility analysis, development of training plans). The implication is that the overall effectiveness of a training program may be highly contingent on the amount of thought and effort devoted at the front end of training design, and companies do not seem to have the capacity to perform this function.

There is also little use of advanced instructional delivery technologies. For example, computer-based training or interactive-video disks are rarely used in smaller companies, although they are increasingly seen in first tier supplier firms, and are relatively common in large manufacturers. (An interesting example of computer-based training in SPC is reported by Lewis, 1986, in which trainees were able to access computerized graphic presentations of common SPC analytic approaches.) A training manager from a large, highly sophisticated automotive OEM estimated that close to 100 percent of instruction in supplier firms is stand up, classroom lectures augmented at a fairly low level of penetration by video technology. Non-interactive video and print materials are generally quite plentiful throughout the supplier chain, but these of course do not have the flexibility or interactive features of other technologies. It is generally still true that the most common instructional delivery system--at least in terms of formal training--is an instructor lecturing in front of a group of people in a fairly traditional manner.

Nonetheless, there are many expectations (or hopes) that the use of electronic instructional media will flower in supplier firms in the next few years. This was a common theme of the respondents to our project-specific survey (Appendix A).

Government Policies, Procurement Practices, and Supplier Training Practices

There tends to be a disparity between the importance and influence of state verses federal initiatives on training and supplier companies. In many states there are active state initiatives to foster training in small to medium-sized companies. In some cases this is done in the context of industrial extensions services or programs (Wyckoff and Tornatzky, 1988), while in other states these activities are affiliated with state departments of commerce, labor or education. Such programs often provide financial aid to companies to pay for training, make referrals to training providers, or conduct some training need assessment. The key in state financing of small firm training is the flexibility and responsiveness of those funding programs. If a firm can obtain state funds quickly, then they will tend to relate to the government programs. Otherwise, training tends to be financed by the firm itself.

While companies which sell either directly or indirectly to the federal government receive less direct assistance for the training function, they may be subject to perhaps more indirect influences or pressures to conduct training. For example, in some federal contracts there are apprenticeship programs which are mandated as part of a contractual understanding.

All in all, the posture and interface between government and the training function in small to medium-sized supplier firms is fairly disaggregated and mutually inconsistent. That is, in some states there is a fairly coherent approach to understanding and addressing the training needs of supplier companies; in other states (and for the most part, in the Federal government) this is little appreciation of, or effort devoted to, the problem. The key features that seem to differentiate the two is how much government officials involved really understand the nature of OEM-supplier relationships, the rapid changes that are occurring in technology, and the linkage to needed skills improvement. One implication is that the "non-system" of government support of supplier training needs to be examined for possible, complementarity, overlap, and redesign.

The Japanese Alternative

The Japanese Supplier Model. The purported "Japanese Supplier Model" is what U.S. OEMs and their suppliers are ostensibly moving toward. The features of the model are fairly straight-forward and should be obvious from much of the discussion above. For one, there is a small number of suppliers serving OEMs in a dedicated manner, with corresponding tiering throughout the supplier chain. Moreover, supplier relationships tend to be longitudinal "partnerships", with much give and take, mutual risk-sharing, and common fate between supplier and customers. For example, there are Japanese reports of supplier firms having a business relationship with a major customer that transcends decades of activity, with little or no formal contractual agreements involved. This is obviously contrary to much of the prevailing norms of the U.S., with the past history of extensive competition on the basis of price, and much in the way of intimidation by procurement practices.

On the other hand, many major U.S. companies are trying to emulate such partner relationships, particularly in the development of new parts and components through simultaneous engineering relationships. As described by Burt (1989), some U.S. companies are involving their suppliers in new product design to the extent of co-locating their engineers on the OEMs premises. As another example, Ford now publishes a list of desired supplier-developed technologies, and often becomes involved in a cooperative manner with research and development activities with a small group of selected supplier firms. Apparently, recent advances in air bag and antilock brake technologies resulted from such arrangements.

Nevertheless, one should not draw from the above the notion that these "partnerships" are warm and fuzzy relationships. Japanese manufacturers are tough customers, and impose stringent requirements for quality, delivery, and cost on their suppliers. On the other hand, there tends to be much more assistance and guidance provided to suppliers by Japanese OEMs, given that they become qualified and dedicated partners.

The U.S. Supplier to the Japanese Transplant. Within the past decade, several major Japanese manufacturers have established assembly operations in the U.S., particularly in the auto industry. These include Mazda, Nissan, Honda, and Toyota. In addition to the numerous intra-organizational innovations in labors relations and management practices which have been extensively documented elsewhere, Japanese transplants have attempted to apply their model of supplier relationships to their U.S. contracts, whether those suppliers are U.S.-based Japanese suppliers or domestic firms. An

excellent discussion of these relationships is described by Hill et al (1989) concerning the evolving culture and inter-organizational sociology of the Mazda plant in Flat Rock, Michigan. They describe a process of supplier qualification and partnership-building, which takes months and in some cases years to consummate. The process includes an initial identification of "candidate" suppliers (with Ford advice), getting price quotes, evaluating prototypes produced by a subset of firms quoting, and then evaluating the plants of the suppliers selected for quality control and other capacities. This latter process has stretched out for some time with a number of suppliers.

There is no persuasive evidence that there are substantive differences between the U.S. company and the U.S.-based Japanese supplier to the Japanese transplant company, once the relationships have been established. To a significant degree, however, the U.S. supplier firm becomes much more "Japanized" through the process. In fact, Mazda has used one of its U.S.-based Japanese suppliers as a model for its U.S. supplier companies to learn from (Hill et al., 1989). A critical issue in terms of public policy is whether Japanese transplants will be willing to engage in this supplier upgrading process on a wholesale scale with U.S. firms, as opposed to merely encouraging their own domestic suppliers to set up U.S. operations. If the former occurs, there is a strong likelihood that this will in time upgrade the quality of the U.S. manufacturing base. (In fact some U.S.-based Japanese suppliers are worried that U.S. suppliers will learn too much of their technology, when they are both part of the same supplier network.) If the latter becomes the prevailing approach, it makes the induced modernization and changes in domestic practices somewhat unstable, given that Japanese suppliers could easily move back off shore, given a different fluctuation in the relative price of the yen and the dollar.

Trends and Future Practices

Likely Structural Changers in Major U.S. Industry. The likely future trends in the structure of customer-supplier relationships in U.S. manufacturing are likely to parallel, albeit accelerate those changes described above. That is, there will be a decrease in the number of firms in the supplier chain, greater tiering, increasing emphasis on quality and quality management, and increasing expectations for supplier firms. As an example of the latter, we can expect an increasing use of modular assembly in OEMs which requires a much closer integration of first and second tier suppliers and their customers. For example, companies like Sheller Globe and Kelsey-Hayes are doing wheel brake assemblies instead of wheels and brakes separately. As described by Braham (1988),

companies such as Parker-Hannifin are now doing design engineering on air-conditioning hose assemblies, which were previously done by the auto makers themselves. Parker-Hannifin does the design engineering for about a quarter of its annual business with industrial customers, with the proportion increasing annually. These developments have implications for a greater utilization of simultaneous/concurrent engineering concepts, embodying a more complete degree of interaction between design and manufacturing functions wherever they be located. For example, not only are we seeing product development teams that include technical staff from both OEMs and suppliers, but also from engineering/design as well as manufacturing functions.

The way and pace at which these changes are unfolding, however, is being perturbed by significant uncertainties in the fiscal and monetary environment. For example, the next recession, or significant changes in the value of the dollar is likely to have major repercussions throughout the supplier chain. Given that suppliers will need to make major investments in both human resources and technology in order to meet the expectations of the new "partnerships", these uncertainties will likely delay investment decisions.

There is also some evidence (Kelly and Brooks, 1988) that the increasing use of computerized production technology may push companies towards a business strategy of product diversification as opposed to single market nichification. For example, the opportunities afforded by flexible automation for rapid changeover and rededication of machining may permit producers to be part of several supplier chains, and at the same time increase machine utilization. Again, the dominate and most economically remunerative pattern of using the new technologies in supplier firms has yet to play itself out, or to stabilize within those firms. Based on available data, the trends are unclear.

As suggested earlier, many of these changes are more acute and manifesting themselves in a more visible manner in traditional, metal-bending industries of the Midwest. This is particularly so in auto and allied industries. It is unclear whether these changes are representative of the U.S. nationally, but it is clear that they are representative of changes in those industries. Auto-related metal fabrication is the same in Long Beach as it is in Livonia.

Implications for Supplier Firms. It is relatively clear as current changes in supplier relations accelerate and expand, that supplier firms will not be able to be responsive unless there are dramatic changes in the way human resources and training practices

are conducted. As noted above, the larger supplier firms who are farther along the path of change, are seeing training as central to their future (Ford et al, 1989) There are several strands of likely changes over the next several years in the training function itself. For example, training will likely become a more visible part of manufacturing strategy among supplier firms, and its delivery will much more of an ongoing integrated function within those companies. We can expect to see greater use of learning centers or analogous innovations in companies, which provides an on-going human resources development function, as opposed to episodic, machine-specific training encounters.

Since many of the structural and associated technological demand parallel changes in organizational practices, we can also expect to see increasing training and development dedicated to group dynamics, communication skills and allied activities. For example, simultaneous engineering and other types of team approaches to technical change can only work in a firm that function well organizationally-speaking.

We are also likely to see an expansion in the use of "job aids", such as expert systems and hypertext that facilitate on the job learning and utilization of information. Since on-the-job training seems to be the model form of instruction in supplier firms, the use of adjunct technologies to facilitate this process is likely.

Even with the growth of internal capacity in supplier firms to address training needs. there will also be a growth in the training industry and out- sourcing of specific training projects. The spin off of ASI (American Supplier Institute) from its origin within Ford Motor Company is an example. Started as a program within the Ford body and assembly division to teach SPC, it grew so fast that in 1985, ASI became an independent and separate entity from Ford. It delivers training and associated service within all the domestic auto makers as well as supplier companies.

In this context, we can also expect an increasing role in the already large burden being carried by community colleges as a external training provider. In many regions or communities, the local technical or community-college is the preferred supplier of contract training services. However, it is also true that for the most part community colleges have performed this function using a "brokering" approach (Jacobs, 1989). That is, rather than developing a stable cadre of industrial instructors to provide customized training projects and services, these operations often work like a contract or body shop, bringing people in from the outside world on an project-by-project basis. One result is that there is little continuity from one project to the next.

Industry customers are likely to become more involved (directly or indirectly) with supplier training in all of these areas. We are likely to see in the future co-development of training programs and activities, joint teaching, greater shared use of common training materials and approaches, and possibly the use of satellite and close circuit training involving OEMs and their suppliers.

The evidence discussed above can be categorized in terms of (1) accomplished facts, (2) likely trends, and (3) possibilities. It seems an inexorable fact that supplier relationships in manufacturing have changed and are changing. Suppliers are fewer, contracts are longer, and customer-supplier relationships are becoming more give-and-take in nature. It is also clear that OEMs have influenced the content and delivery of training in supplier firms--but only in certain technical domains. Virtually all of the direct intervention has been in the quality and SPC domain, a logical extension of the changes in the business relationship.

The likely trends are that the training influence will expand into other domains. Some logical extensions, as OEMs seek to remedy other cost-drivers, include the design function, and industry-specific technology foci. Regarding the former, it is relatively clear that modular sourcing, and enhancing the engineering role of supplier firms, will both have human resource and training (also education) implications for supplier firms. It is also relatively clear that nobody has seriously addressed those issues.

It is unlikely that industrial customers will become involved intensively in the delivery function itself. The role thus far has been providing materials, setting expectations, and some limited degree of direct delivery. This is not likely to change.

Policy Implications

In many ways the initial concern of suppliers to adopt training programs such as SPC and quality have been meet through a series of state programs and initiatives in the private sector. While many of these programs have lacked an emphasis on continuous quality improvement, and there have been problems with the actual implementation of what has been taught within the firm, there has been an impressive proliferation of activity in the area of SPC and Quality.

However the next phase of supplier-customer relations will call for a greater emphasis upon the implementation of advanced production and design technologies, and a more highly educated workforce at the supplier shop. As noted above, the next stage of productivity improvement can only be obtained with computerization, as well as driving

the engineering function down into the supplier structure. This suggests a number of policy issues and a potential role for the Federal government:

1. There is a shortage of engineering personnel at the level of the supplier firm, and there may be a Federal role to encourage the training of applied engineers, with generalist backgrounds, who can work in that setting. It is clear that the engineering background of the present individuals who use that title in the supplier firms is woefully uneven. In many cases the "engineer" is a former skilled worker--or a younger student fresh from a community college program in programming. The supplier firms will need many trained engineers, but ones with practical shop floor experience to handle the demands that will be placed upon them in the next phase of implementation of technology. Most Federal programs that promote science and engineering--such as those within NSF--tend to promote theoretical research and Big Science with little effort to gear programs to the needs of the supplier firms. While there are 2 and 4 year colleges in virtually every state to partially address this need, they are typically underfunded and ignored by science and technology policy makers.

2. The major Federal legislation that deals with vocational education is the Perkins Act, which while attempting to promote secondary and post secondary institutions to maintain "current" with industry, is designed to award funds to serve specific categories of students (displaced homemakers, handicapped, etc.). The Act never deals with the firm as a category of user, nor encourages educational institutions to develop programs to meet the needs of specific industries or regional clusters of industries. There needs to be some Federal encouragement of vocational educators to have some of the monies given to schools in the form of Perkins to utilize for the specific technology needs of the smaller supplier shops.

3. This analysis has confirmed a continuing dearth of training delivery capacity in the subtier supplier firm. Smaller firms typically have neither the personnel, nor make use of the available instructional technology, to mount anything other than episodic and reactive training activities. It is unclear what are the critical ingredients in this state of affairs, nor what is the private-public remedy. It might involve a more efficient system at the university level to turn out industrial trainers; it might involve waiting for the creation of cheaper and more flexible instructional technologies; it might call for incentives for OEMs to underwrite a supplier-dedicated ongoing training capacity. For example, it is difficult for a single supplier firm to justify the capital investment necessary to get up to speed in electronic media. However, with appropriate incentives, OEMs might be willing to make these investments in their supplier networks, including the development of content materials. Nonetheless, this is a subject for

additional, more detailed and empirically precise analysis, whether by OTA or another interested party.

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APPENDIX A - REPORT OF SURVEY

Introduction

In August and September of 1989 the Industrial Technology Institute conducted a small, focused survey of a small number of manufacturing companies. This effort was part of a larger analytic study being conducted for the U.S. Congress, Office of Technology Assessment. In subsequent sections we will describe the sample, approach, and results of that study.

Sample

Data were gathered from a total of 15 respondents. The approach used to develop the sample was "snowball" in nature. That is, a number of potential respondents were known by the project team, and these constituted the first wave of interviews. During the interviews, other candidate respondents were identified and served to supplement the initial list. Finally, some individuals were identified as a result of parallel literature review activities. Respecting individual and institutional needs for confidentiality, the sample of completed interviews consisted of the following:

- A small supplier of injection molded plastic components to the auto and business machine industries.
- A small supplier of oil pumps and governors to various industries.
- A small supplier of machined parts to auto and other industries.
- An operator of non-profit policy organization in the training field.
- A manufacturer of specialized assembly and test equipment, primarily a supplier to the auto industry.
- A supplier of tooling and jigs to various industries.
- A major appliance OEM (original equipment manufacturer).
- A small supplier of precision machine tools to various industries.
- A supplier of seats to agricultural implements industry.
- A producer and supplier of paints and industrial finishes to agricultural implements and other industries.

- A small supplier of die castings to various industries, primarily auto.
- A small supplier of parts to the aerospace industry.
- A small foundry, supplier to various industries.
- A supplier of machine tools and tooling.
- An automotive OEM, considered innovative in its supplier relations.

Method and Approach

An 8 page, 15 question interview protocol was used. Potential respondents were initially contacted, and if possible an interview was conducted on the spot. If not, an appointment was made for a specific time and date. Roughly 50% of potential respondents either declined to be interviewed, or were unable to be scheduled within the time frame of the study. Interviewers took notes of the interviews as they were conducted.

Results

The results from the survey will be presented in terms of individual question responses, and will generally follow the structure of the interview protocol (Appendix B). In addition, some overall impressions will be noted.

Changes in Customer-Supplier Relationships. It is clear that relationships are changing (virtual unanimity among the respondents), and the driving force behind these changes is the demand for increased quality. Ten of our respondents indicated that quality is a preeminent demand from customer, 2 others felt the emphasis on quality might be more apparent than real, and others felt that traditional cost criteria still predominated. A healthy minority of respondents felt that there were changes away from adverserial relationships between customers and suppliers, including longer term contracts and providing training and guidance to customers. Nonetheless, many felt that the suppliers were being asked to make most of the changes, and to take more direct responsibility over the management of quality.

Technology Drivers. To the extent that technological change is driving the restructuring of customer-supplier relations, that change is in the "soft" technologies. A major of our respondents (9 of 15) identified SPC or related statistical techniques and capacities as being the driving influence. A small, but healthy, minority of respondents (4 of 15) pointed to computers and various programmable technologies as contributing to the changes. Others identified changes in organizational or management practices.

Impacts on Training. There are obvious and significant impacts on the training function of supplier firms as a result of the changes mentioned above. Virtually all of our respondents indicated that more training is or will be done. They also mentioned deficits in the skills of the workforce, in general and in specifics (e.g., math and computer skills). Several indicated that the net result will be that more of the training load will fall onto supplier firms themselves.

OEM Involvement in Supplier Firm Training. On the basis of our limited survey results, there appears to be great diversity in the role that OEMs are playing vis-a-vis their suppliers. For example, over half (8 of 15) of our respondents knew of courses or seminars offered by OEMs directly to supplier firm personnel. On the other hand, 5 of our respondents felt that OEMs were doing essentially nothing. Several (5 of 15) indicated that OEMs were influencing the training function by establishing guidelines concerning the content of their mandated quality programs, and in some cases providing materials or conducting audits. Overwhelmingly, it appears that OEM involvement is concentrated in a relatively narrow substantive domain (quality), and has yet to assume a consistent form. This appears to be a significant discriminator between OEM behavior.

Japanese Comparisons. Many of our respondents (6 of 15) had little direct knowledge of Japanese practices in this area. Of those who had, a majority felt that U.S. and Japanese company practices were moving in the same direction, and that the U.S. has almost caught up ("70% there"). A couple interesting distinctions were drawn however. Three of the respondents, with fairly extensive knowledge of the behavior of Japanese companies in the U.S., felt that the Japanese approach to implementing quality as well as influencing training tended to be more detailed and operational in its approach. Japanese OEMs were seen as much clearer and explicit about conveying their expectations, more likely to take a hands-on and bottoms-up approach, and not to demand vague changes.

General Impacts on Human Resource Practices. Changed customer-supplier relationships are apparently having cascading impacts on human resource functions that go beyond training qua training. For example, several of our respondents (5 of 15) indicated that with the increased demands on skills, the recruitment of new employees is increasingly critical, as well as more difficult. There also appears to be more immediate training of entry-level workers, as well as changes in policies and practices so as to reduce the turnover of employees, such as greater emphasis on promotion from

within. Aside from being better employees in a technical sense, this increased investment in human capital has reportedly had other "fringe benefits". Three of our respondents indicated that increased training has reduced the need for other human resource services, and has made workers more generally adaptive and flexible. Several respondents (4 of 15) could not identify discernible changes in human resource practices.

Long Term Trends. Three issues seemed to preoccupy respondents as they divined future trends. One is the perceived trend toward closer and more dedicated customer-supplier relationship. Second is simply more training and the need for even greater skills in the workforce. Third was the likely increased use of computerization in manufacturing, as well as other sophisticated technologies.

Training Practices: Current and Future. Despite significant changes in training technologies in recent years, as well as increasing understanding of the complexity of the training function, training as practiced in supplier firms is still pretty basic. By a wide margin, the most frequent vehicle for training is OJT, followed by formal classroom instruction, with some sprinkling of electronic instructional media (e.g., video disc, computer-assisted-instruction). There is also great disparity across firms. Some rely exclusively on OJT; others use formal classroom instruction for a majority of their training. There is also apparently heavy use made of instructional materials (e.g., manuals) provided by vendors.

Despite limited current use of electronic training technologies, this is seen by respondents as the wave of the future. The modal response (7 of 15) tended to focus on the promise of interactive electronic media, computers, video, and the like. Respondents were apparently seeing the potential of interactive electronic media to capture the benefits of active instruction that is analogous to, for example, classrooms and OJT, and combine it with the economies of scale of these media.

Delivery Infrastructure: Present and Future. The dominant mode (12 of 15 respondents) of training delivery appears to be "in-house", with local community colleges a strong second, followed by equipment vendors. There are also various permutations and combinations of these infrastructural elements (e.g., courses that are packaged by community colleges and then offered internally). One respondent noted that content which is either highly technical or highly proprietary would not likely be delivered by external sources.

There was little consensus about what will be the future mode of delivery

infrastructure. A majority (8 of 15) could see no major changes over the next 5 years, or also had no opinion about what they might be. Another group of respondents (7 of 15) saw an increasing role for external delivery organizations, either community colleges or training vendors. Interestingly, a few of these respondents saw the trend to the outside as being driven by the need for more specialized and professional training.

Innovation and Obstacles to Change. The majority of the respondents could not point to any single example of an innovative approach to training in supplier firms. Of those who could, there was no clear trend or predominant theme, although innovations that involved electronic media were most frequently mentioned.

On the other hand, the respondent group was quite clearly composed (10 of 15 responses) on what were the obstacles to more effective training in supplier firms. In a word: cost. Additional, better training costs money, and thus far supplier firms themselves (with some assistance by government) are shouldering most of those costs. A secondary reason for slow progress was simple resistance to change. Heretofore, training has been a relatively low priority item for most manufacturing firms. It has only recently - and as yet incompletely - been seen as a key to competitive advantage.

Summary Comments. On the basis of this limited survey "reconnaissance" some tentative conclusions can be drawn. Manufacturers, small and large, definitely see changes in the nature of customer-supplier relations, and the link that these changes have to supplier firm training activities. Many of these changes seem to be driven by the quest for product quality, and secondarily by changes in production technology per se. Although there is great diversity across OEMs' institutional behavior, their role vis-a-vis their suppliers has been relatively low key - providing guidelines, materials, and a very limited amount of direct training assistance. This is not too dissimilar from the posture of Japanese OEMs operating in the U.S., although the latter tend to be somewhat more structured and explicit in their relations with their suppliers. For the most part, training as delivered in supplier firms tends not to be state-of-the-art in format or delivery. It is usually in-house, heavily OJT, and makes only limited use of advanced instructional technologies.

APPENDIX B - PHONE PROTOCOL

RESPONDENT

(To be filled out in advance)

Name_____

Company/Affiliation_____

Phone_____

Preamble

Hello. My name is ———, and I am a —— at the Industrial Technology Institute. We are conducting a study for the Office of Technology Assessment, of the U.S. Congress, and would like to spend about 30-45 minutes getting your opinions about an important public policy issue. Is this a good time? (IF NOT, GET DATE_____ AND TIME_____ for call back.

The purpose of the study is to assist the Congress in its understanding of the relationship between training and the use of new manufacturing technologies and organizational practices. In particular, the study is focusing on how changes in these areas is occuring in small to medium-sized firms who are suppliers to larger original equipment manufacturers (OEMS). To summarize: we are interested in changes in the training function; associated changes in OEM-supplier relationships; and how trends in technology and business practices might be driving those changes.

I would like you to consider about a dozen questions. In responding to each, please give me your informed opinion. We would also like to get a real "feel" for the topic, so if you can give any examples or cases, it would be helpful.

1. How would you describe changes that are occuring in the relationships between suppliers and their customers, and vice versa? PROMPT: For example, do you see an increasing emphais on quality, cost reduction, new technologies?

2. How is technological change driving those changes that you have just described? PROMPT: What process technologies are suppliers being asked to use? What changes in organizational or business practices?

3. How are the changes that you have described in the first two questions impacting the way in which the training function is conducted in small to medium-sized supplier firms?PROMPT: Are skill deficiencies in the work force an impediment to implementing new technologies?

4. In what ways are OEMs directly guiding or assisting the training function in supplier firms?

5. How do the practices that you have described compare with what Japanese companies are doing in the U.S. with their suppliers, whether those supplier are U.S. or Japanese companies? PROMPT: For example, do you see Japanese companies emphasizing changes in training or human resource practices more than U.S. companies?

6. In what ways are changing supplier relationships, and changing training practices, having a more general impact on <u>human resource</u> practices in supplier companies?

7. What long term trends in either technology or business relationship are likely to accelerate changes in the training practice in supplier firms? How will this play out?

8. What training techniques or technologies are being used to deliver training of the workforce? For example, what is the mix of classroom training, on the job training, use of electronic media, and so on.

(9. What changes in the next 5 years in training techniques or technology are likely to impact how (and how well) supplier firms deliver training?

10. Could you describe the education/training infrastructure that provides workforce training? For example, how much is provided in-house? by private training vendors? by Community Colleges?

11. What changes are likely to occur in that infrastucture over the next 5 years that will impact how (and how well) supplier firms acquire workforce training?

12. Can you identify some particularly innovative examples of how technical training is delivered in supplier firms?

13. What are the primary impediments to supplier firms improving their training function? How are OEMs part of the problem and/or part of the solution?

14. Do you have any other final comments about this topic?

15. Can you think of anybody who it would useful for us to talk to about these issues? We are particularly interested in talking with individuals in SMALL supplier companies, and those in industries outside of traditional durable goods. Name? Affiliation? Phone number? Can we use you as a reference?